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THE CORAL REEFS OF TUTUILA, SAMOA

THE preparation of a detailed chart—not yet published—of Tutuila, Samoa, by the U. S. Hydrographic Office, and the studies made by various scientific specialists invited to the island by Dr. A. G. Mayor, director of the department of marine biology of the Carnegie Institution of Washington, have added greatly to the knowledge of that remote possession of ours in recent years. The chart, on a scale of about 1 : 50,000, shows the mountainous volcanic island to be surrounded by an extensive submarine bank, from one to three miles wide, somewhat shallower near its inner and outer margins than along an intermediate belt, where soundings of 60 fathoms occur. The shallower parts of the bank are interpreted as submerged fringing and barrier reefs, which are supposed to rest on a wave-cut platform now lying between 60 and 70 fathoms below sea level by reason of island subsidence. The present shores of the island are embayed and are bordered by well developed fringing reefs.

Dr. Mayor's latest Carnegie report contains a condensed statement by R. T. Chamberlin, entitled "The geological interpretation of the coral reefs of Tutuila, Samoa," the result of three weeks' observation there in July, 1920, from which the following extracts are taken:

> The island of Tutuila is a volcanic pile whose slopes have been attacked by the sea until a broad wave-cut platform, 2 miles in width, has come to surround the island. This broad shelf of planation, originally cut in the volcanic rocks not far below the sea level, now lies at least (though probably not much more than) 400 feet below sea-level. . . . On the outer margin of the wave-cut platform, corals commenced to build a barrier reef, while a fringing reef grew outward from the shore. . . . Subsequently the island became progressively submerged. . . . Tutuila, therefore,

is consistent with the Darwin-Dana coral-reef hypothesis to the extent that a submergence of 400 feet has occurred since the corals began to form the old barrier reef; but in other respects it does not fit the requirements of that hypothesis, inasmuch as the barrier reef, instead of being built up several thousand feet from the slopes of a sinking island, is found to be rooted on a broad, wave-cut platform.

Dr. Mayor comments on Chamberlin's statement in part as follows:

> Professor R. T. Chamberlin, who made a special study of the relation between the reefs and the volcanic shores of the island, . . . finds that the ancient barrier and fringing reefs which once surrounded the island and are now drowned grew upon a platform which had been cut by the sea and afterwards submerged and not upon the unaltered slopes of the island. Thus the Darwin-Dana theory does not apply to Tutuila.

Chamberlin's summary concerning the origin of the reefs is excellent as far as it goes, and it is to be presumed that if he publishes a fuller account of his results he will then supplement the present brief statement with an explanation of the conditions which determined that Tutuila should be for a time reef-free and therefore exposed to abrasion before it became reef-encircled, and with a description of the high cliffs that must have risen at the back of the now submerged 2-mile platform and of their relation to the recently cut cliffs the base of which is close to actual sea level.

But excellent as the present summary is with respect to the reefs of Tutuila, neither the passage above quoted from it nor the passage quoted from Mayor's comment upon it does justice to Darwin's theory of coral reefs; for in so far as the quoted passages imply that the submerged barrier reef of Tutuila does not exemplify the "Darwin-Dana" theory, they hold good only for an imperfect, indeed an incorrect conception of that theory. As a matter of fact the Tutuila reefs, both submerged and at present sea level, exemplify certain special phases of Darwin's theory in a remarkable manner, as the following citations from his "Structure and Origin of Coral Reefs" (1842) will make clear.

In the first place, Darwin nowhere asserted that barrier reefs must be "built up several thousand feet from the slopes of a sinking island," or that they could not be built up from a "broad, wave-cut platform," as Chamberlin implies, or that they must grow up from "the unaltered slopes of an island," as Mayor assumes. All that Darwin's theory of barrier reefs and atolls demands is that a foundation of any form shall subside slowly enough for the reef to grow upward and maintain its surface at sea level. The form of the foundation is immaterial. It is true that the typical island profile which Darwin drew in two figures (pp. 98, 100), to represent a subsiding foundation on which a fringing reef would be transformed into a barrier reef and a barrier reef into an atoll, showed an island of a particular form, as graphic illustrations always must; but as this profile was modeled upon that of the island of Bolabola, a deeply denuded member of the Society group, it effectually disposes of Mayor's assumption that Darwin thought reefs grew up from "the unaltered slopes of an island."

It is true that Darwin nowhere wrote anything about the denudation of Bolabola, but he was perfectly familiar with the fact that the slopes of volcanic islands are altered by erosion and abrasion. His geological philosophy was somewhat primitive, for he thought that many volcanic islands had been uplifted after their conical form had been produced by eruption, and that during the resulting emergence the sea cut valleys in the island slopes; it was, indeed, by this process that he accounted for the repeated breaching of certain original "basaltic rings," composed of outward dipping lava beds, and their conversion into a circuit of separated hills, such as characterize the islands of "St. Jago" in the Cape Verde group, St. Helena, and Mauritius. He also knew that "deep arms of the sea . . . penetrate nearly to the heart of some [reef] encircled islands," Raiatea in the Society group being mentioned as one of them; and the depressions occupied by such sea arms were surely understood

to be alterations from the original form of the islands. Hence there is no warrant whatever for thinking that Darwin's theory demands the growth of reefs on unaltered volcanic slopes.

The particular kind of alteration caused by the abrasion of circum-insular platforms was very properly not shown in his type diagram, because, so far as Darwin's observation and reading went, no barrier reefs were known to have grown up from foundations of that kind. He knew full well, however, that platforms might be abraded and that reefs might grow upon them; but he believed that, unless subsidence occurred, such reefs would differ from ordinary barrier reefs in having shallow lagoons behind them, as will be shown below.

Various passages in his book make it clear enough that no particular form of reef foundation was regarded as essential. Anything on which a reef might begin its growth would suffice. For example, Darwin wrote: "If the rim of a [non-subsiding] crater afforded a basis at the proper depth, I am far from denying that a reef like a perfectly characterized atoll might not be formed; some such, perhaps, exist; but I can not believe in the possibility of the greater number having thus originated" (89). And again: "A bank either of rock or of hardened sediment, level with the surface of the sea, and fringed with living coral, would . . . by subsidence be converted immediately into an atoll, without passing, as in the case of a reef fringing the shore of an island, through the intermediate form of a barrier reef" (101). Evidently, the prime element in Darwin's theory of barrier reefs and atolls was subsidence; no particular form of the foundation on which reef growth begins was assumed, except for purposes of graphic illustration. Such illustration always involves definite profiles; but the more general statements of the text show that definite profiles are not required.

Moreover, a careful reading of Darwin's book will discover that he clearly conceived the possibility of a reef growing up from the outer margin of an abraded platform, as now appears to have been actually the case on Tutuila; and that he gave this possibility little consideration, not because such a reef would not grow upward into a true barrier if the platform subsided, but only because he found no examples of it. He wrote:

> It will, perhaps, occur to some, that the actual reefs formed of coral are not of great thickness, but that before their first growth, the coasts of these encircled [non-subsiding] islands were deeply eaten into, and a broad but shallow submarine ledge thus left, on the edge of which the coral grew; but if this had been the case, the shore would have been invariably bounded by lofty cliffs, and not have sloped down to the lagoon channel, as it does in many instances (49).

Certain volcanic islands that Darwin had seen in the Atlantic, before he was concerned with the origin of coral reefs, had made him familiar with the visible occurrence of sea-cut cliffs; and the "broad but shallow submarine ledge" that must extend forward from the base of the cliffs was apparently familiar by inference. Thus he described St. Helena as surrounded by "enormous cliffs, in many parts between 1,000 and 2,000 feet in height," and added that "the swell of the Atlantic ocean has obviously been the active power in forming these cliffs." In various other reef-free islands he recognized "the prodigious amount of degradation, by the slow action of the sea, which their originally sloping coasts must have suffered, when they are worn back, as is so often the case, into grand precipices."[2] He does not explicitly announce the contrast between the "grand precipices" of volcanic islands that are not defended by encircling reefs, and the moderate slopes that lead "down to the lagoon channel" in nearly all reef-encircled islands; but he knew and correctly described both classes of islands.

In view of all this it is manifest enough that, if Darwin had at hand the facts now known about Tutuila, he would have said, in effect:

> Tutuila is an actual island which must formerly have been "deeply eaten into" by the sea, and which must then have been surrounded by a "broad but shallow submarine ledge" backed by

[2] "Geological Observations," 1844, 91, 128.

"lofty cliffs"; yet the very fact that most other barrier reef islands are not "bounded by lofty cliffs" but "slope down to the lagoon channel" shows that they have not been "deeply eaten into"; or if they have been then the resulting cliffs have been completely submerged by later subsidence.

His general scheme of upgrowing reefs on subsiding foundations therefore takes in without any difficulty the special case of an island around which a platform had been abraded.

Good reasons may be given for believing that the peculiar case of completely submerged platform-back cliffs, just alluded to, is a very probable one; for wave-cut platforms and cliffs presumably occur as normal features in an early, pre-reef stage of young volcanic islands; and their rarity to-day is best explained by the strong subsidence of the islands since the platforms were cut; but the discussion of this question would lead away from the matter here under consideration.

Another passage from Darwin's book, directly following the one above quoted about the possibility of reefs growing on the coast of an island that has been deeply eaten into by the sea, is pertinent here, as it explicitly considers the growth of a reef upon a platform margin and the depth of the resulting lagoon:

> On this view,[3] moreover, the cause of a reef springing up at such a great distance from the [non-subsiding] land, leaving a deep and broad moat within, remains altogether unexplained.

Or otherwise phrased: If a reef sprang up from the outer margin of a broad platform, cut by waves around a still-standing island, the enclosed lagoon could not be so broad and deep as barrier-reef lagoons usually are, unless subsidence had occurred along with reef growth. The quoted statement is not so clear as Darwin's writing generally is, but the modified phrasing here suggested is believed to represent his fuller meaning; it is certainly consistent with the context. In any case, Darwin clearly knew that a platform could be abraded around a volcanic island and that such a platform must be backed by cliffs; and he further believed that, if a reef grew up on the margin of the platform, the lagoon thus enclosed would not have the depth of most barrier-reef lagoons; but that if the abraded island subsided and the reef grew higher, the depth that is usually found in barrier-reef lagoons would thereupon be produced. According to the present understanding of the coral-reef problem, it is precisely the occurrence of such subsidence that puts a stop to further abrasion by making reef-growth on a platform margin possible; but Darwin did not detect this point, nor did he see that the opportunity for abrasion of platforms around volcanic islands in the coral seas is best provided, as above mentioned, when the islands are young and high, with simple, non-embayed margins, so that a large amount of detritus shall be washed down from their steep slopes to the shore, where its accumulation in beaches inhibits coral growth and permits abrasion. Indeed, this explanation of the condition under which the abrasion of a platform may occur is not mentioned even in Chamberlin's summary, though its omission there may be due rather to the conciseness of the summary than to a rejection of the explanation. The explanation has, however, a considerable theoretical importance in giving reasonable consideration to an early pre-reef stage of island development that has been generally overlooked;[4] and it was in view of this explanation that the common occurrence of completely submerged platform-back cliffs was above suggested as probable in barrier-reef islands; but the platforms associated with these submerged cliffs need not have been nearly so broad as the submerged platform of Tutuila.

It may be added that the opportunity for platform and cliff cutting on Tutuila can not be advisedly ascribed to the inhibition of coral growth by the lowered temperature of the lowered Glacial ocean, as is postulated

[3] A footnote in Darwin's book at this point reads: "The Rev. D. Tyerman and Mr. Bennett . . . have briefly suggested this explanation of the origin of the encircling reefs of the Society islands."

[4] "Clift Islands in the Coral Seas," *Proc. Nat. Acad Sci.*, II., 1916, 283–288.

in the Glacial-control theory of coral reefs; for if the Tutuila platform had been cut to a width of a mile or two in volcanic rock under such conditions, similar platforms should have been cut around other volcanic islands, and the tops of the platform-back cliffs should be visible to-day above normal sea level; but as a matter of fact such partly submerged cliffs, or plunging cliffs as they may be called, have not been often detected; besides Tutuila, the other best known examples are Tahiti and the Marquesas islands, as will be further told below.

To return to Darwin's text: a further examination of it discovers a remarkably close parallel to the actual condition of Tutuila, as the following statement will show. The Tutuila barrier reef is now drowned; its successor is a fringing reef on the marginal slopes of the abraded island; and these slopes are, according to Mayor, steeper than the sides of the valleys by which the island is dissected. Now in view of the association of fringing reefs with rising or stationary coasts in Darwin's theory—as it is ordinarily quoted—it might be thought that the occurrence of the Tutuila fringing reef around a subsided island contradicted his views. But that such is not the case is made clear by this prophetic sentence:

> If during the prolonged subsidence of a shore . . . an old barrier reef were destroyed and submerged, and new reefs became attached to the land, these would necessarily at first belong to the fringing class (124).

That is precisely the case at Tutuila. Evidently, it is immaterial whether the "old barrier reef" here mentioned had been formed by upgrowth from the slopes of a non-abraded, subsiding island, or by upgrowth from the margin of a platform on an island that subsided after the plaform had been abraded. Darwin's suggested explanation is excellent; it was only because he found no examples of fringing reefs thus produced that he did not pursue the suggestion further; but fringing reefs of this kind abound in the Philippine Islands.[6]

If it be true that the submerged barrier reef of Tutuila was formed on a subsiding platform of marine abrasion, one or two miles in width, the cliffs at the back of the platform should have been 1,000 feet or more in height. Hence the upper part of their faces ought still to be visible after a subsidence of some 400 feet; and it should therefore be on the now submerged part of the cliff faces that the present fringing reefs of Tutuila have been formed. Mayor's accounts of Tutuila tell, however, of narrow platforms backed by steep cliffs a few hundred feet in height that have been cut close to present sea level since the submergence of the barrier-reef platform. It would therefore seem that these new cliffs must have been cut in the slanting faces of the earlier and greater cliffs after their partial submergence. This relation of the two sets of cliffs has not been mentioned, as far as I have learned, by any observer on Tutuila; it is a "flier" of my own,[7] based on the dimensions of the new cliffs and platforms as reported by Mayor. The relation of the height of these cliffs to the breadth of the platforms at their base suggests that the inclination of the preexisting spur-end surfaces in which the new cliffs have been cut was much steeper than the ordinary radial slope of the spurs on a dissected volcanic island, but not steeper than the precipitous descent which the earlier-cut, spur-end sea cliffs might have had at the back of their two- or three-mile platform; and as the cliffs at the back of so wide a platform must have had some such height as 1,000 feet, the upper part of their slanting faces should be still visible as plunging cliffs after a 400-foot subsidence. Furthermore, the idea that the new cliffs of Tutuila are cut in the earlier ones gains some support from photographs of Tutuila by Mayor, and from photographs of the Marquesas islands by Iddings; for these islands appear to resemble Tutuila in many respects, although their submerged platforms, the presence of which is indicated by a few soundings in front of their plunging cliffs, are

[6] "The fringing reefs of the Philippine Islands," *Proc. Nat. Acad. Sci.*, IV., 1918, 197–204.

[7] "The islands and coral reefs of Fiji," *Geogr. Journal*, IV., 1920; see p. 218.

not yet well enough known to warrant any statement as to whether they bear submerged reefs or not; and although new sea-level fringing reefs are not yet developed on the Marquesas cliffs, for Mayor reports the growth there of only separate corals on the cliff faces below sea level. A corollary of this last-mentioned fact is that the submergence of these islands must be more recent than that of Tutuila.

Had the old barrier reef of Tutuila not been drowned by a too rapid submergence—possibly the result of subsidence at an ordinary rate reenforced by the Postglacial rise of ocean level—it would have to-day formed a sea-level barrier reef enclosing a fine lagoon; and it would have thus imitated the barrier reef which surrounds Tahiti, where the island spurs are strongly cut off in plunging cliffs between embayed and mostly delta-filled valley mouths, thus indicating that the visible barrier reef of Tahiti, like the submerged barrier reef of Tutuila, has grown up from an abraded, cliff-backed platform. It may be parenthetically added that the form of the larger valleys of Tahiti, now embayed and delta-filled, suggests some such measure as 600 or 800 feet for the submergence of the inferred cliff-base platform; also, as the Tahiti reef now reaches sea level and as most of the drowned-valley embayments there are filled with deltas, that island must have been submerged less rapidly and less recently than Tutuila. And to this it may be added that the submergence of Tutuila must, as already noted, have been less recent, but perhaps not more rapid than that of the Marquesas, where not even fringing reefs are yet formed; and finally that local subsidence of these different islands, varying in rate and in amount from place to place, and not a synchronous and uniform rise of the ocean, must be taken as the cause of their non-synchronous and non-uniform submergences.

But if this view concerning barrier reefs be correct, it might be objected that neither the submerged barrier reef of Tutuila nor the sea-level barrier reef of Tahiti was formed according to Darwin's theory, because according to that theory—as it is usually quoted—barrier reefs are supposed to have developed from on-shore fringing reefs, while the Tutuila and Tahiti barrier reefs appear to have developed from off-shore, platform-margin reefs. Yet even this contingency is provided for in Darwin's wonderfully well reasoned discussion, as may now be briefly pointed out.

It is true that Darwin's type figure represents the initial stage of reef growth as an on-shore fringe around a rather steeply sloping island border; and that the fringe is transformed, as subsidence progresses, first into a barrier reef and later into an atoll; and from this it has been generally inferred that, when Darwin described barrier reefs and atolls as developed from fringing reefs, on-shore fringes must have been meant. But a closer examination of his text leads to a different conclusion. His chapter on fringing reefs defines them in a manner that appears to have been generally overlooked. He included in that chapter not only reefs closely attached to the shore of their islands, but also other reefs "not closely attached." Several off-shore reefs on the shelving sea floor of Mauritius and off the east coast of Africa are there presented as examples of detached fringing reefs:

> On the western side of Mauritius . . . the reef generally lies at the distance of about half a mile from the shore; but in some parts it is distant from one to two, and even three miles (52).

Again, on the eastern coast of Africa,

> For a space of nearly forty miles, from lat. 1° 15′ to 1° 45′ S., a reef fringes the shore at an average distance of rather more than a mile, and therefore at a greater distance than is usual in reefs of this class. . . . In the plan [small chart] of Mombas (lat. 4° S.) a reef extends for thirty-six miles, at the distance of from half a mile to one mile and a quarter from the shore (56).

None of these off-shore reefs has "an interior deep-water channel," but only a shallow one. It is therefore by the absence of a deep lagoon and in spite of the detachment of these reefs from the shore that they are, in Darwin's terminology, classed as fringing reefs and distinguished from barrier

reefs. Whether modern observers will adopt his terminology in this respect or not is aside from the point here at issue. The fringing reefs which Darwin regarded as the early stage of barrier reefs may have been either on-shore reefs or off-shore reefs; but if off-shore, the belt of water between them and the land must have been shallow. This is made perfectly clear by his explicit statement:

> Fringing reefs on steep coasts are frequently not more than from 50 to 100 yards in width; they have a nearly smooth, hard, surface, scarcely uncovered at low-water, and without any interior shoal channel, like that within those fringing reefs which lie at a greater distance from the land (55, 56).

These citations leave no doubt that, when the now-submerged barrier reef of Tutuila was first formed at a distance of a mile or two from the cliffed inner border of its shallow supporting platform, it would have been classed by Darwin as a fringing reef, because the "enclosed water channel" was then of small depth. But when subsidence continued and permitted reef upgrowth to such a height that the enclosed water channel or lagoon was increased in depth, then Darwin would have called it a barrier reef, as modern observers are united in doing.

The principle here involved is, however, of no great importance, because it was not Darwin but his successors who have emphasized the supposedly necessary sequence of fringing reef, barrier reef, and atoll, as a consequence of the theory of subsidence. Darwin's own discussion recognized this succession as characterizing the typical example of a subsiding island, like Bolabola; but he explicitly recognized other sequences in less typical cases. If the original reef foundation had been a bank close to sea level, the initial fringe would have become an atoll, as subsidence progressed, "without passing . . . through the intermediate form of a barrier reef," as a quotation (101) already made shows clearly enough. Or if a reef grew up from the rim of a still-standing submarine crater of proper depth, a possibility which Darwin explicitly recognized (89), an atoll would be formed without the preliminary formation of a fringing or a barrier reef. The point of all this is that Darwin conceived many conditions under which coral reefs might be established and transformed, and did not restrict himself to a special form of reef-foundation or a fixed sequence of reef development, even though he understood that the most probable explanation of the majority of barrier reefs is by the more or less intermittent upgrowth of fringing reefs from subsiding foundations, and that the best explanation of most atolls is by similar upgrowth from subsiding barrier reefs.

The object of this article is to point out that the full meaning of Darwin's broad discussion can not be condensed into a rigidly conceived theory, beginning with an island of a certain shape and proceeding through a perfectly definite sequence of transforming reefs. His treatment of the problem was far broader than that, as the citations given above must suggest, and as various other citations would confirm. Far from being inconsistent with his broadly conceived theoretical discussion, the reefs of Tutuila as described by Mayor, Chamberlin and others are remarkably close exemplifications of some of its most significant special phases.

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May, 1921

A NOVEL MAGNETO-OPTICAL EFFECT

EARLY in April, 1921, while my son, Malcolm Thomson, was operating, in a building of the River Works plant of the General Electric Co., a resistance welder for closing the seams of steel Langmuir mercury vacuum pumps, in which work the current is applied and cut off at about one half second intervals, there was noticed by one of the working force, Mr. Davis, who happened to be favorably located, a peculiar intermittent illumination of the space near the welder as the current went on and off. My son at once placed himself in a similar position and saw the novel effect, and noted a number of conditions accompanying it, perhaps the most important being that a single turn loop from the welding transformer to

the work and back was carrying about 7,000 ampères, and that the luminous effect was spread in the space in which would be located the magnetic field from this loop; that the sunlight was entering the building through high windows and shining across the space in which the field was produced at intervals; that the effect was most conspicuous when one looked towards the shadows, and across the sunbeams, and also across the magnetic field.

This would be expressed by saying that the best effect was observed when the line of vision was downward at an angle intersecting the entering sunbeams, and into the shadows under the beam furnished fortunately by a partition a few feet high, over which the sunlight came. The magnetic field, neglecting the curvature of the lines, was, generally speaking, at right angles to the line of sight and to the direction of the sunlight. My son also noticed that the effect of increased luminosity was coincident with the putting on of the current and disappeared at once on cutting off the field. It was thus clear that it depended on the establishment of the magnetic field. He reported these facts to me and they were confirmed by me. Other observers were soon enlisted, and on several favorable sunny days all the above observations were confirmed by them. Further, my son had not been able to see any effect when looking across the sunbeam from the opposite side. This means that with the sunbeams streaming in from the south, the effect was observed looking southward and downward; the windows admitting the light being to the south. Looking from the south across the beam gave no result, though it was not possible to look directly across the beam on a slant upward into any dark shadows and at the same time have the line of vision cross the magnetic field.

It is interesting to note at this point that the luminosity filled the whole space and extended as far away as four feet or more from the magnetic loop, and that it was not especially noted as more intense near the loop than at a distance therefrom of say two feet or more.

Mr. Malcolm Thomson had further observed that by cutting out the loop from the secondary terminals (clamps) of the welding transformer and simply joining those terminals by an iron bar, as is done in resistance welding, the luminous effect in the neighborhood of the transformer was still visible, but was much more feeble than when the heavy loop was used. It occurred to me to examine the light by a large Nicol's prism. It was found that there was a distinct polarization of the light from the space. This means that when the magnetic field was on, the sunlight was scattered in the direction of the observer, from the space occupied by the sunlight beam and the magnetic field, and that such scattered or deflected light was polarized.

It occurred to me, as a possible factor in the case, that as the building was used in part to carry on arc welding by iron arcs, there might be suspended in the air of the building iron particles or finely divided oxides or compounds of iron, which in some way were oriented by the magnetic field, resulting in the scattered light noted. This was confirmed in part by making the test observations when the large doors of the building had been open for some hours. The effect was present though difficult to detect. This led to the suggestion to bring an iron arc into operation near the space in which the luminous effect had been seen. This was done and with an enhancement of the effect.

At this stage, the further observations were carried on in the Thomson Laboratory at Lynn, Mass., with the aid of the laboratory corps (A. L. Ellis, H. L. Watson, Dr. Hohlnagel, and others).

Two sets of test apparatus were prepared at my suggestion. One large welding transformer was mounted in a special room, into which the sunbeams could be received in the afternoon, as the windows faced south by west. The secondary terminals were joined by a large loop of heavy copper cable about 12 square centimeters section and of a loop diameter of .6 meter. The loop consisted of two turns. The plane of the loop was vertical and was nearly north and south, or in a plane parallel to the direction of the entering sun-

beams, so that the magnetic field would be in the main horizontal and transverse to the light of the sun entering downward as before. An iron arc was arranged to be operated so that the smoke from it would rise from below and enter the field of the loop, and by changing the relative position of the arc, the smoke column, widening as it rose, could be made to bathe the turns of the coil, cross its axis, or at a distance away, merely enter the field. As the experiments thus far had always involved connection to the shop plant, with 60 cycle A. C. current, a check apparatus was set up, consisting of a storage battery (of a type such as is used in automobile starting) arranged on a stand. In circuit with it, and under control of a switch was a coil of about .2 meter diameter and giving a field due to about 2,500 ampère turns when the switch was closed. This second apparatus could be moved about and was entirely independent of supply circuits, or static dusturbances which might be present in them.

The first tests were made with the transformer loop (representing a field of 20,000 ampère turns) and were very striking. The rising smoke from the small iron arc, only moderately visible in the sunbeam, became decidedly luminous when the field was put on. Each closure of the current switch to the primary of the transformer was instantly followed by the brilliant smoke effect, and the effect instantly disappeared on the opening. A black background had been provided in front of which the smoke rose. After the arc had been running a few minutes only, it was seen that the air of the room was carrying sufficient of the smoke particles to give the effect anywhere in the space covered by the magnetic field and the sunbeams, even a number of feet away from the coil. In this case the appearance was as if in the air there were diffused some substance or material which only became visible in the combined sunlight and magnetic field. That in this case the luminous effect is not greater near the coil loop than feet away, indicates that orientation, or whatever causes the effect, is complete even in a rather weak field. Thorough ventilation of the room by opening windows, caused the effect to fade out gradually by removal of the active particles.

The experiments with the D.C. current coil and battery conclusively showed that the effect was present with it, as with alternating current, and incidentally established the fact that the effect on the particles is independent of the direction of magnetization. It is doubtful if high frquency tests would allow us to discover whether the establishment of the effect requires time. Probably not. Observations made through the axis of the loop of two turns show a minimum of effect, from which it may be inferred that it is not present if the viewing is exactly along the field line direction.

Polarization. — Having obtained, as described in the foregoing, a controllable and relatively brilliant source of the luminosity, tests with the Nicol's prism were resumed. It was soon noted that the polarization was decided as controlled by the magnetic field. Moreover, the very curious fact was discovered by me that the fumes from the iron arc were composite so far as analysis by the polarizing prism was concerned. The bluish colored smoke arising gave but little effect, but there was with it a yellowish gray fume, which was highly luminous in one position of viewing by the prism and invisible when the prism was at right angles to that position. This indicates complete polarization when the field is on, for the light diffused from the particles in the yellowish gray fumes. This is an extraordinary effect, for which no evident explanation suggests itself, for the field lines are not straight but wrap themselves around the coil or loop in curved directions, and the effect is apparently complete even with the fumes rising in the space where the lines are strongly curved.

It remains to use a vertical beam of light and make tests from opposite directions across the field, also to use artificial light instead of sunlight. The design of a small demonstration apparatus seems possible, consisting of a coil to be put on a battery or lighting circuit, A.C. or D.C., a small iron arc between two wires, a box with darkened interior to be filled with

fumes, having two sides of glass, one for the admission of the light beam and the other a window at right angles for observation. Two coils placed outside the box space and opposite each other, or capable of application in different relations will have advantages. The addition of eye shields to cut out extraneous light and a tortuous chimney conveying the smoke but cutting off the light from the iron arc are desirable additions to the equipment, as also an analyzer as part of the apparatus for the polarization effect.

The Microscope.—Attempts have been made to catch the particles in the smoke from the arc upon a glass slide for microscopic examination as to their form under high powers. That they are exceedingly fine is evident from their remaining in suspension so long in the air and diffusing themselves rapidly throughout the air. That an exceedingly small amount of material suffices for making the whole air of a large room capable of showing the effect is evident also. The sunbeam may enter the room and its course is not disclosed by them unless the magnetic field exists. It seems natural to suppose that the particles consist of some form of iron or iron oxide, but without proof this can not be fully decided. Other particles might exist giving such an effect, but it must be confessed this does not seem probable. Other fumes and smokes from arcs so far have given no results. The smoke from a nickel arc does not give the effect. Neither does a cobalt arc yield fumes behaving like iron smoke.

The fumes and smoke of an iron arc were caught on a clean microscope slide until a patch of sediment of a slightly yellowish brown tint, but very pale, was deposited. Under moderate powers, very little of any definiteness is shown, but under the high power of an oil immersion lens of about 1.5 mm. focal length, there is disclosed a curious structure of particles seemingly between .0002 and .0001 mm. diameter, which particles are frequently strung together, 4, 5, 6, or more, in a line, giving the effect of a short piece of chain made of small roundish particles, slightly spaced apart, or of a short section of a string of beads (round beads) not touching one another. Many of these structures appear to be straight, and some are curved. Evidently in a magnetic field these chains of particles, presumably of oxide of iron, and magnetic, would line up and reflect or diffuse light of the sun striking them. If the direction of vision was such as to favor polarization of the rays in a direction nearly at right angles to the incidence of the solar beam, the polariscope effect would be accounted for, measurably. Aside from polarization, the lining up of the chains would also account for the extra *visibility* of the smoke under the conditions of the experiment.

It would seem from the foregoing that a considerable length of column of smoke from the iron arc, and subjected transversely to a magnetic field, might be expected to act as a means for obtaining polarized light in the direction of the beam itself. This assumes that there will be a considerable scattering of light polarized as above described in a direction sidewise, leaving the light which passes through polarized in a plane at right angles. The apparatus might be compared in its action to a Nicol's prism, transmitting rays in one plane and throwing out laterally those in the other plane. This suggestion will be tested as soon as proper arrangements can be made.

The polarized light which is sent out from the smoke particles in a direction transverse to the sunlight beams, when the magnetic field is put on, is in the same plane as that reflected from a sheet of glass at the polarizing angle receiving the same beam. This fact is in accordance with what might be expected if the short sections of chain or beaded particles were oriented or lined up by the magnetic field; the transverse waves of light vibrating in a plane intersecting the length of the chains would not be deflected on account of the extremely small diameter of the particles composing them, but waves vibrating in the plane of the length of the chains would be reflected to the side and this would account for their plane of polarization being what it is. Such waves would behave as if reflected

from short rods in line with the plane of vibration, while the extremely small diameter of the rods would not sufficiently intercept the light vibrating in a plane transverse to their length.

It is expected to continue the investigation with artificial light and other varied conditions, followed by a later account.

ELIHU THOMSON
THOMSON LABORATORY OF GENERAL ELECTRIC CO., LYNN, MASS.
May 23, 1921

EDWARD BENNETT ROSA

DR. EDWARD B. ROSA, chief physicist of the Bureau of Standards, at Washington, died suddenly at his desk on Tuesday afternoon, May 17, 1921. Dr. Rosa was at the time the chief of Division I. of the Bureau of Standards, the functions of which include research, standardization and testing in the fields of electricity, magnetism, photometry, radio communication, radium, X-ray, and public utilities. Dr. Rosa was appointed physicist in the Bureau in 1901. In 1910 he was given the grade of chief physicist. Dr. Rosa's painstaking accuracy in scientific research is well known among specialists in the fields in which he worked. His investigations have been published in 36 scientific publications of the bureau and 4 technologic papers, not to speak of a large number of special reports, circulars, and articles in technical journals.

Among the researches of unusual interest may be mentioned the precise determination of the value of the coulomb, the value of the ampère, and of the ratio between the electrostatic and the electromagnetic units of electricity. His other laboratory researches included a wide range of problems chiefly connected with the improvement of the standards and methods used in precise electrical measurements.

Perhaps one of the most striking examples of Dr. Rosa's thoroughness and success in securing the cooperation of the technical groups interested may be found in the development and publication of the National Electrical Safety Code, the revised form of which has just recently appeared as a "Handbook" issued by the Bureau of Standards.

In his work as administrator he successfully organized the work of electrical testing, photometry, radium testing, and research and standardization work involved in radio communication. Dr. Rosa showed a deep interest in all phases of the bureau's development, and will be remembered with profound respect and admiration by his colleagues. His work will endure as a permanent foundation for the branches of physics and electrical engineering to which he devoted so many useful years of his life.

S. W. STRATTON
DEPARTMENT OF COMMERCE, BUREAU OF STANDARDS

SCIENTIFIC EVENTS

THE HARPSWELL LABORATORY

THE Harpswell Laboratory was founded at South Harpswell, Maine, in 1898, as a summer school of biology by Dr. J. S. Kingsley, then professor of biology in Tufts College, Massachusetts. In 1913 it was reorganized as a scientific corporation under the laws of the state of Maine, with a board of ten trustees. Up to 1920, ninety-two scientists have worked in its laboratory at South Harpswell and over one hundred and ten papers have been published, as a result of this work, in American and foreign journals of biology.

In the spring of 1921 the Harpswell Laboratory became a member of "The Wild Gardens of Acadia" Corporation, and this corporation alloted to the Harpswell Laboratory a tract of land of abundant acreage for its purposes and further growth at Salisbury Cove, Maine, on Mount Desert Island, with shore frontage and favorable life conditions, upon which the Harpswell Laboratory has established its Weir Mitchell Station. In its new site the laboratory is in close contact with the wild life sanctuary of Lafayette National Park, created recently on Mount Desert Island by the United States through the efforts of a group of its summer residents. This is the only National Park in the eastern portion of the Continent and the only one in the country

in direct contact with the sea. This secures a permanent and rich area for biological study in every field, vertebrate and invertebrate.

Salisbury Cove is an old fishing and farming hamlet on the north shore of Mount Desert Island about five miles from the town of Bar Harbor and on the county road from it to the town of Ellsworth on the mainland, where there is a railroad station and junction. The village of Salisbury Cove is a market gardening and farming community of quiet and simple kind, but Bar Harbor has good stores of every sort, an excellent hospital, express, telegraph, cable facilities, good train service. The class in zoology will be conducted by the acting director, Professor Ulric Dahlgren, of Princeton University, and two assistants, for six weeks, from July 6 to August 17, in which types of the principal groups of the animal kingdom will be studied as to their habits, structures and classification, together with a number of the more important subjects of general biology. Independent research workers may obtain rooms that can be occupied from June 25 to September 15.

PRESENTATION TO DR. FREDERICK BELDING POWER

Dr. Frederick Belding Power, chemist in charge of the phytochemical laboratory, Bureau of Chemistry, Department of Agriculture, was presented with a gold medal by Mr. Henry S. Wellcome, of London, before a gathering of distinguished guests, in the auditorium of the Cosmos Club, on the afternoon of May 9. The medal was given in recognition of Dr. Power's distinguished services to science during eighteen and one half years as director of the Wellcome Chemical Research Laboratories of London.

Dr. Charles D. Walcott, secretary of the Smithsonian Institution, presented the medal to Dr. Power on behalf of Mr. Wellcome, who although present was suffering from a severe throat affection. In his address Dr. Walcott spoke briefly of the life and discoveries of Dr. Power:

We have gathered here this afternoon to do honor to Dr. Frederick Belding Power, who for fifty years has spent his thinking hours among the complicated molecules of organic compounds; who, because he possesses that peculiar faculty of exhausting each subject which he takes up, has had the greatest influence both in America and Great Britain in raising the standards of our pharmacopœias; who has gained distinction by his most difficult and life-consuming researches into the chemical composition of plant compounds.

Dr. Power graduated from the Philadelphia College of Pharmacy in 1874, in the same class with his life-long friend, Mr. Wellcome, who urged him to pursue his studies in Germany. He spent the years from 1876 to 1880 in Strassburg, becoming the assistant of Flueckiger, one of the greatest pharmacologists of Europe. Returning to America, he spent nine years in the organizing and building up of the department and school of pharmacy in the University of Wisconsin, four years in researches on essential oils in a newly organized chemical works near New York, and in 1896 Mr. Wellcome appointed him director of his chemical research laboratories in London.

For eighteen and one half years he devoted his time exclusively to chemical research and the direction of a staff of research workers under him. One hundred and fifty important memoirs were published from the laboratories during this period. These covered a wide field of investigation, for which material was obtained from all parts of the world. Among these a very notable and complete study was made of the East Indian chaulmoogra oil, which resulted in the discovery of some physiologically active acids of an entirely new type. These form the basis of the new treatment of leprosy which gives promise of affecting a complete cure of one of the most terrible diseases of mankind.

During these years in London, Dr. Power had the opportunity of meeting and forming the close friendship of the foremost scientific men of Great Britain. The recognition of his work by the leading chemists and other scientists of Europe would be perhaps exemplified in the high tribute paid to him by the late Lord Moulton, one of the most learned and versatile men in Europe, who was entrusted by Kitchener with the task of producing the high explosives for the war. Shortly before his death he chided Mr. Wellcome for permitting Dr. Power (who for family reasons had returned to America) to leave Great Britain, for, as he remarked, "there was no one in Europe who could fill his place."

Dr. Walcott then formally presented the medal to Dr. Power, who expressed his appreciation of the honor bestowed upon him and his gratitude to Mr. Wellcome, saying:

I can assure you that this memento will always be regarded by me as one of my most precious possessions. As I stand here there come to me many happy recollections of the friendship that has continued for nearly half a century. It was twenty-five years ago when I left America to take charge of the laboratories.

There is one thought that is dominant in my mind, however, and that is an expression of gratitude to Mr. Wellcome. I am grateful for his encouragement and inspiration, but above all for having possessed for so many years so kind and true a friend.

MEDALLION OF THE WISCONSIN ACADEMY OF SCIENCES

A MEDALLION with which the Wisconsin Academy of Sciences, Arts and Letters commemorates its recent semi-centennial has been completed by Leonard Crunelle, Chicago sculptor, and is described in an article written by President E. A. Birge, of the university, for the forthcoming *Transactions of the Academy*.

The medallion bears the portraits of six distinguished members of the academy. Its obverse bears the figure of Minerva tending the lamp of learning and a motto from Lucretius, "Naturæ species ratioque." The reverse carries the inscription, "The Wisconsin Academy of Science, Arts and Letters, 1870–1920," and the portraits of the following six members:

William Francis Allen, hsitorian, professor of Latin and history at the university, 1867–1889, a great teacher and scholar; president of the academy from 1887 to 1889.

Thomas Chrowder Chamberlin, geologist, professor at Beloit College 1873–1882, director of the Wisconsin Geological Survey, 1876–1882, in charge glacial division of U. S. Survey, 1882–1887, president of the University of Wisconsin 1887–1892, head of the department of geology in University of Chicago, 1892–1919, now professor emeritus, Chicago; president of the academy, 1884–1887.

Philo Romayne Hoy, physician, naturalist, practising in Racine from 1846 to his death, ardent student of bird life and the biology of Lake Michigan; president of the academy, 1875–1878.

Roland Duer Irving, geologist, professor in the university from 1870 until his death in 1888, important member of the Wisconsin and U. S. Geological surveys and a leading authority on the geology of the Lake Superior region, 1873–1888; president of the academy, 1881–1884.

Increase Allen Lapham, naturalist and geologist, resident of Milwaukee 1836–1875; collector and cataloguer of plants and fossils; state geologist, 1873–1875; charter member of the academy and its secretary from its organization until his death in 1875.

George Williams Peckham, zoologist, teacher, high school principal and superintendent of schools in Milwaukee, 1873–1896, head of Milwaukee public library, 1896–1914; authority on habits and classification of insects; president of the academy, 1890–1893.

The medallion was made possible by a fund of $1,200 for designing it and making the dies. This was donated by the following friends: A. J. Horlick, Racine; F. A. Logan, Chicago; F. P. Hixson, La Crosse; Mrs. C. W. Norris, Milwaukee; and E. A. Birge, T. E. Brittingham, C. K. Leith, M. S. Slaughter, and C. S. Slichter, all of Madison. Other friends have contributed to a fund by which copies of the medallion will be distributed.

The six members were chosen partly for their intellectual eminence for their services to the academy, and in part for the periods in which their lives and activities fall. Three of them, Chamberlin, Hoy, and Lapham, were charter members. Each of the six served as president, except Lapham, who was secretary from its beginning until his death in 1875.

SCIENTIFIC NOTES AND NEWS

ON Mme. Curie's return from the Grand Canyon and Yellowstone Park, the Wolcott Gibbs medal was conferred on her by the Chicago Section of the American Chemical Society, and she was entertained by the University of Chicago and by the associated women's organizations. After a visit to Niagara Falls she proceeded to Boston, where among other functions a dinner was given in her

honor by the American Academy of Arts and Sciences. Mme. Curie planned to visit New Haven this week to be present at the installation of President Angell on June 22. She expected to sail with her daughters for France on June 25.

Dr. Carl L. Alsberg, having resigned as chief of the Bureau of Chemistry of the Department of Agriculture, to accept a position as one of the three directors of the Food Research Institute established at Stanford University by the Carnegie Corporation, the bureau chiefs of the department gave him a farewell dinner at the Cosmos Club on June 17. Dr. L. O. Howard acted as toastmaster and Assistant Secretary Ball spoke informally and Dr. Alsberg replied.

At the annual commencement of the Worcester Polytechnic Institute on June 10, the class of 1871 celebrated the fiftieth anniversary of its graduation, and H. P. Armsby of that class received the honorary degree of doctor of science, this being the first honorary degree ever conferred by the institute.

The degree of doctor of science was conferred on Dr. Edward Kenneth Mees, research chemist of the Eastman laboratory, at the seventy-first commencement of the University of Rochetser.

Indiana University has conferred the degree of LL.D. on W. S. Blatchley, formerly state geologist of Indiana.

Franklin College at its commencement on June 8 conferred the honorary degree of doctor of humane letters on Dr. Albert Perry Brigham, professor of geology in Colgate University.

Miss Annie J. Cannon, of the Harvard College Observatory, has received from Groningen University in Holland an honorary doctor's degree in mathematics and astronomy, in acknowledgment of her work in the study of stellar spectra.

At the anniversary meeting of the Linnean Society of London on May 24 its Linnean gold medal was presented to Dr. Dukinfield H. Scott, for his services to recent and fossil botany.

Professor Dwight Porter, since 1883 a member of the civil engineering department of the Massachusetts Institute of Technology, and for twenty-five years professor of hydraulic engineering, has retired.

We learn from *Nature* that Dr. W. T. Calman, who has been in charge of the Crustacea at the Natural History Museum since 1904, the author of "The Life of Crustacea" and of numerous articles on this group, has been appointed deputy keeper in the department of zoology.

A number of changes have recently been made in the scientific staff of the Australian Museum, Sydney. Dr. C. Anderson, who has been mineralogist since 1901, succeeds the late R. Etheridge, Jr., as director. Mr. A. Musgrave fills the vacancy caused by the death of W. J. Rainbow, entomologist, and Messrs. J. R. Kinghorn and E. le G. Troughton, second-class assistants, have been promoted to be first-class assistants in charge of reptiles, birds and amphibians, and mammals and skeletons, respectively.

Dean Albert R. Mann, of the New York State Agricultural College at Cornell University, has declined the position of head of the New York State Agricultural Department. Reference was made in Science to "candidates" for this position. The word was not intended to imply that the position was being sought by the scientific men in question, but that their qualifications were such as to have led to the consideration of their appointment.

Dr. T. Mitchell Prudden has been elected a member of the International Health Board of the Rockefeller Foundation. Dr. Anthony J. Lanza, of Cleveland, has been appointed by the board to inaugurate a department of industrial hygiene in the new ministry of health in Australia.

Professor George Grant MacCurdy has leave of absence from Yale University for the academic year 1921–22. With Mrs. MacCurdy he sailed for Europe on June 18 to become the first director of the American School in France for Prehistoric Studies. The school is scheduled to open at the rock shelter of La

Quina near Villebois-Lavalette (Charente) on July 1.

DR. HUGH H. YOUNG, director of the James Buchanan Brady Institute, Johns Hopkins Hospital, will sail, June 25, for Europe. He will go first to Paris to attend a medical meeting and later to London, returning to the United States in August.

THE Oxford University expedition to Spitzbergen is not only biological, as was stated in a note of our issue of May 13, nor mainly ornithological. It will include three zoologists, three ornithologists, a botanist, a geologist, a glaciologist, a geographer, a mineralogist, and a meteorologist, who, together with Dr. T. G. Longstaff will constitute an inland sledging party to explore and map an untouched area of New Friesland. Mr. Seton Gordon is accompanying the expedition as photographer. Mr. Julian S. Huxley is organizing the scientific work apart from the ornithology, which is under the direction of the Rev. Francis C. R. Jourdain.

A CONFERENCE on conservation of resources of interior waters, called by the Secretary of Commerce, met at Fairport, Iowa, June 8 to 10. The chairman was Professor Stephen A. Forbes, of the Illinois State University and State Natural History Survey. Vice chairmen were Professor Herbert Osborn, Ohio State University; Carlos Avery, Minnesota State Fish and Game Commission; Professor H. C. Cowles, University of Chicago; J. E. Krouse, Davenport, Iowa; and Dr. A. T. Rasmussen, La Crosse, Wis.

A GRANT of $450 has been made by the Committee on Scientific Research of the American Medical Association to Dr. Herbert M. Evans of the University of California for the continuance of his researches on the relations between ovulation and the endocrine glands.

UNIVERSITY AND EDUCATIONAL NOTES

THE Carnegie Corporation and the General Education Board have each given half of $3,000,000 to the medical department of Vanderbilt University as an endowment. Funds for the erection of new buildings are available from appropriations of $4,000,000 made by the General Education Board in 1919.

NEW YORK UNIVERSITY has received a gift of $150,000 in memory of Dr. A. Alexander Smith, from Mrs. Helen Hartley Jenkins to complete the endowment of the department of medicine, for which Mrs. Jenkins had previously given the sum of $100,000.

DR. C. H. CLAPP, president of the Montana State School of Mines at Butte, has been elected president of the State University of Montana, to succeed Dr. E. O. Sisson, who recently resigned.

AT the annual meeting of the university senate and board of trustees of Syracuse University there was established a research professorship in zoology, and Professor Charles W. Hargitt, since 1891 head of the department of zoology, was made its first incumbent. At his own request Professor Hargitt is relieved from active direction of departmental routine and Professor W. M. Smallwood becomes director.

DR. JOHN W. M. BUNKER, formerly instructor in the department of sanitary engineering at Harvard University and for the last six years director of the biological laboratories of the Digestive Ferments Company, has been appointed assistant professor of biochemistry at the Massachusetts Institute of Technology.

DR. CHRISTIAN A. RUCKMICK, of the University of Illinois, has accepted an appointment as associate professor of psychology in Wellesley College.

DR. E. V. COWDRY, since July 1, 1917, professor of anatomy at the Peking Union Medical College, Peking, China, has resigned that position to accept an appointment as associate member of the Rockefeller Institute for Medical Research. Dr. Davidson Black, formerly associate professor of embryology and neurology of the Peking College, has been appointed professor and head of the department of anatomy at the Peking College, succeeding Dr. Cowdry.

DISCUSSION AND CORRESPONDENCE

NEWTON'S CORPUSCULAR THEORY OF LIGHT

To the Editor of Science: For more than half a century various text-books on physics and other publications dealing with the phenomena of light, contain assertions to the effect that Newton's corpuscular theory of light received a knock-out blow when it was demontrated that light required a longer time to pass through water than through air.

Quoting, for example, from the last (11th) edition of the Encyclopædia Britannica, Vol. XVI., page 618, we read:

> In the earlier part of the 19th century, the corpuscular theory broke down under the weight of experimental evidence, and it received the final blow when J. B. L. Foucault proved by direct experiment that the velocity of light in water is not greater than that in air, as it should be according to formula (1), but less than it, as is required by the wave theory.

The object of this note is to show that the observed data are just as favorable for Newton's theory as they are for the wave theory of light.

Compared with Newton's corpuscle, the hydrogen unit of chemistry must evidently be regarded as a very large mass.

In passing between the molecular masses (H_2O) of which the water is composed, the path of the corpuscle would be much longer than the path in air between the widely separated N_2, O_2, H_2O and other masses. Consequently, if the ratio of the actual length of the path in water to the actual length of the path in air is greater than the ratio of the velocity in water to the velocity in air, the time required for the corpuscle to pass through the water with the greater velocity, will be longer than that required to pass through the air.

J. M. Schaeberle

Ann Arbor,
May 31, 1921

GERMAN SURTAXES ON SCIENTIFIC PUBLICATIONS

To the Editor of Science: I read with interest the letter of M. W. Senstius in Science for April 8, 1921, in which he stated that a publisher in Leipzig had informed him that he had "abolished all foreign surtaxes on journals published by his firm," and that the publisher stated further that it was a "matter of regret to him that he is not (yet?) at liberty, owing to the binding regulations of the Börsenverein, to do the same with his own books."

I at once wrote to the publisher, Wilhelm Englemann, stating that I had read Mr. Senstius's letter in Science, and inquired whether the journal—*Botanische Jahrbücher*—was included in his list of exempt publications, and what the subscription rate of the periodical would be to us. I give below a close English translation of Mr. Engelmann's reply under date of May 2, 1921:

> In answer to your very valued letter of April 12, 1921, may I reply that Mr. Senstius in his article in Science of April 8 emphasizes that all the journals *which appeared from my press after January 1, 1921, would be supplied without the exchange tax (Valuta Aufschlag)!*
>
> On all journals and sets (Sammelwerke) appearing before the end of 1920 there is a publisher's additional charge (surtax, *Verlegerteuerungszuschlag*) of 200 per cent. plus, at the time only, 100 per cent. exchange tax exempt! In accordance with the enclosed circular this publisher's surtax was increased from May 1, 1921, to 300 per cent. of which you will please take note!
>
> With reference to Series I., Botan. Jahrbücher, this 300 per cent. is charged, plus the Valuta additional!

On the back of Engelmann's letter were two notices rubber-stamped, the first stating that his firm would supply all periodicals issued after January 1, 1921, without the Valuta charged, but the second rubber-stamped notice stated that on account of the unusually stringent conditions, there would be added a 300 per cent. publishers' excess charge on all of his publications which appeared previous to the close of 1920, as stated in the letter just quoted. The enclosed circular, to which his

letter referred, contained the same statement, indicating in addition that the 300 per cent. additional charge would become effective on and after May 1, 1921.

C. STUART GAGER
BROOKLYN BOTANIC GARDEN

QUOTATIONS

CENTENARY OF THE FRENCH ACADEMY OF MEDICINE

OUR Paris correspondent has told of the celebration, beginning Dec. 20, 1920, of the most important anniversary connected with French medicine—the centenary of the Academy of Medicine, which has the same preeminence in medicine that the general French Academy bears in relation to the more liberal arts. Its roster bears only the names of those who have by years of achievement won recognition in the profession, and there are few below middle life who have been accorded the honor of election. Trousseau, who received the academy prize in 1837 for his classical treatise on laryngeal phthisis, was considered unusually fortunate in that he gained admission in his thirty-sixth year. The academy was founded in 1820 by royal edict of Louis XVIII., although its name appeared as early as 1804 as an entirely ephemeral institution, the chief interest attaching to it being that Dr. Guillotin was one of its presidents. The French Revolution, with its ruthless submergence of all that pertained to the old order of things, dissolved all medical associations, and among these the Academy of Surgery and the Royal Society of Medicine, which after nearly a century of existence disappeared, to come to life again in the founding of the present Academy of Medicine. The initial concept of the academy was the formation of a body which, by its scientific labors and achievements, should be an asset to the state in matters of public health. The decree which constituted it lays down certain functions which it was to carry on. Among them were improvements in the method of vaccination against smallpox, the measures for the control of epidemic diseases, regulations as to and concerning legal jurisprudence, and the examination of and passing on new remedies, together with the limitation of the sale of nostrums, both those of French and those of foreign origin. While the present academy still holds the latter function, its work, to a large degree, is hampered by the administration of French law, as was pointed out in a former editorial.

The *Bulletin* of the Academy for Dec. 20–22, 1920, is devoted to a review of the history and labors of the society since its foundation. It records a century's achievement by men whose names are known the world over: Pinel, Laënnec and Broussais in the early days; Trousseau in the thirties; Villemin and Pasteur, and on down through the list of those who have added to the sum of certain knowledge which has lifted medicine from scientific guesswork to the dignity of a precise science.—*Journal of the American Medical Association.*

SPECIAL ARTICLES

RESISTANCE TO STEM RUST IN KANRED WHEAT

A CYTOLOGICAL study of *Puccinia graminis tritici* on Kanred wheat, conducted by the Office of Cereal Investigations in cooperation with the California Agricultural Experiment Station, has yielded several facts of interest.

The strain of stem rust under observation and herein reported was obtained from the Berkeley breeding plats. Seedlings of susceptible varieties of wheat grown in the greenhouse produced abundant pustules but, in repeated trials with Kanred, the fungus failed even to produce flecks.

It was found that the urediniospores germinate readily on Kanred leaves and that the germ tubes make their way directly to the stomata. On reaching a stoma, the tip of the germ tube swells to form an appressorium and practically all of the protoplasm flows into it, leaving the germ tube empty. Under favorable conditions for germination these appressoria develop promptly and in great numbers. Often one may observe two, three, and even four spores, with their appressoria, crowded together at a single stoma.

In spite of this, relatively few appressoria enter the stomatal slit in Kanred to form my-

celium within the host. Six days after inoculation, only five out of a hundred appressoria had entered. Material taken eight, ten, and even twelve days after inoculation still showed numerous appressoria and a relatively limited number of infections. For greater accuracy, counts were made and the results tabulated as follows:

No. of Days after Inoculation	Total No. of Sporelings Counted	No. of Entries	Percentage of Entries
6	100	5	5
8	133	14	10 +
10	77	7	9
12	145	16	11 +

Under the conditions of this experiment, only about ten per cent. of the young rust fungi enter. The other ninety per cent. remain outside the stomata until they dry and fall off. By the twelfth day, under greenhouse conditions, practically all the appressoria are withered and collapsed.

Tangential sections of Kanred and Mindum leaves were examined. In these the stomatal slit was measured in length, in width at center and at its widest point, which is near the end, and averages taken. The same was done with Mindum, a durum variety somewhat resistant to this strain of rust. The stomatal aperture in Kanred is extremely long and narrow, while that of Mindum, a less resistant variety, is short, and very variable in width, the average width being about *twice* that of Kanred. In Mindum, the rust sporeling enters freely, while in Kanred nine tenths of them are excluded. It is possible that the naturally small stomatal opening of Kanred is still further narrowed by the action of the guard cells when an appressorium comes in contact with the stoma. A more comprehensive and fully illustrated account, including similar observations on other varieties of wheat, and reporting resistance phenomena which follow actual infection, is now in preparation.

Ruth F. Allen

College of Agriculture and United States Department of Agriculture, Cooperating,
Berkeley, California

THE AMERICAN CHEMICAL SOCIETY

ROCHESTER MEETING

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

H. N. Holmes, *chairman*
S. E. Sheppard, *secretary*

Symposium on Contact Catalysis

Platinum black and carbon monoxide. Esterification by silica gel: C. H. Milligan and E. Emmet Reid. A mixture of equivalent amounts of acetic acid and ethyl alcohol has been passed over silica gel at 150°, 250°, 350° C. It has been found that silica gel is a very active catalyst, more than twice as active as titania, the best catalyst previously known for this reaction. When the mixture is passed rather slowly at 150° the percentage of esterification is 75 to 80, which is much beyond 67 per cent., the accepted limit for this reaction.

Adsorption by oxide catalysts and the mechanism of oxidation processes: A. F. Benton.

Dissociation of some mixed oxides: J. C. Frazer.

The adsorption of gases by metallic catalysts: H. S. Taylor and R. M. Burns. The adsorptions of hydrogen, carbon monoxide, carbon dioxide and ethylene by finely divided nickel, cobalt, iron, copper, palladium and platinum has been found to be of a specific character quite different in nature from adsorption by porous inert adsorbents of the charcoal type. The extent of adsorption was shown to be a function of the mode of preparation and to be especially less pronounced the higher the temperature at which the metal was prepared. The analogy of this fact with the corresponding facts of catalytic behavior has been noted. Adsorption isotherms at 25° C. of hydrogen with nickel, and of carbon monoxide with copper have shown that adsorption increases rapidly with increasing partial pressures below 300 mm. and becomes practically independent of pressure above this pressure.

The action of nickel on diethyl ether: A study in contact catalysis. Preliminary report: Francis L. Simons. A report is given of preliminary work in the study of the catalytic decomposition of ether by nickel. The study was undertaken in the hope of throwing light on the mechanism of the action of nickel on alcohol and the simpler esters. The apparatus used is described in detail and the general procedure given. From the results so far, it appears that ether is decomposed into H_2, C_2H_4 and CH_3CHO, as Bancroft suggests. The compo-

sition of the gas evolved during the reaction is satisfactorily explained on this basis. The work is being continued.

R. p. m. as catalyst: C. H. MILLIGAN and E. EMMET REID. It has long been known that ethylene can be used in place of ethyl chloride in the preparation of ethyl benzene by the Friedel and Crafts reaction but the absorption rate is so slow under usual conditions that the method has not been attractive for preparing ethyl benzene. We find that the reaction can be made to go so rapidly by using a high speed stirrer that this becomes an efficient preparation method. A mixture of 250 g. benzene and 50 g. aluminum chloride absorbs as much as 1,800 c.c. of ethylene per minute when stirrer is run at 1,300 r. p. m.

Catalysis in the interaction of carbon with steam and carbon dioxide: H. A. NEVILLE and H. S. TAYLOR. The catalytic activity of alkali carbonates, alkaline earths and various salts in promoting reaction between steam and carbon has been shown to be paralleled by similar effects in the acceleration of interaction of carbon and carbon dioxide. In each case potassium carbonate has been found to be the most active salt catalyst. Reduced nickel promotes interaction of carbon and carbon dioxide markedly. In explanation of the mechanism of the two reaction processes it has been shown that adsorption of carbon dioxide by carbon at 445° C. is markedly increased by addition to the carbon of such accelerating agents, although these latter themselves show no adsorptive capacity for the gas.

Catalysis in the reduction of oxides and the catalytic combination of hydrogen and oxygen: R. N. PEASE and H. S. TAYLOR. Oxygen and water vapor, present in hydrogen used for reduction of copper oxide, markedly inhibit the action; addition of reduced copper to the oxide appears to accelerate the reaction. The induction period in the reaction is attributed (*a*) to initial drying of the oxide, (*b*) to slow initial formation of copper which then acts as a catalyst. It is doubtful whether the catalytic combustion of hydrogen and oxygen in presence of copper can be represented as an alternate oxidation and reduction process as it has been found that when hydrogen containing oxygen is passed over copper oxide at 150° C., no appreciable water is formed and, at lower temperatures, the activity is reduced as the catalyst becomes progressively oxidized. The formation of water in presence of copper may take place through interaction of hydrogen on an oxygen molecule which is in process of combining to form oxide, that is, at the instant of collision with the copper surface.

A case of autooxidation: $MnO_2 \rightarrow HMnO_4$: J. C. FRASER.

Oxidation and reduction by organic compounds: C. H. MILLIGAN and E. EMMET REID.

The action of alumina, titania, and thoria on ethyl and isopropyl acetate: HOMER ADKINS and A. C. KRAUSE.

The catalytic electrolytic oxidation of SO_2: COLIN G. FINK. The electrolytic oxidation of SO_2 with various anodes was investigated. It was found that graphite anodes will catalyze the oxidation providing ferrous-ferric ions are present in solution. In the absence of iron, no catalytic effect due to the graphite could be observed. On the other hand, an inert anode such as ferrosilicon, in the presence of ferrous-ferric ions will not catalyze the SO_2 oxidation. The combined effect of the graphite anode and the iron is essential to accelerate the reaction.

The decomposition of ethyl acetate induced by catalytic nickel: HOMER ADKINS and P. W. SIMMONDS.

The catalytic influence of foreign oxides on the decomposition of silver oxide, mercuric oxide and barium peroxide: JAMES KENDALL and FRANCIS J. FUCHE. The effect of foreign oxides on the temperature and rate of decomposition of silver oxide, mercuric oxide and barium peroxide under an oxygen pressure of one atmosphere has been experimentally investigated. In almost all of the systems examined, the added oxide induces a considerable change in the decomposition temperature. Most commonly there is a marked lowering in this point; thus (to cite an extreme case) an equimolecular mixture of BaO_2 and CuO has an oxygen equilibrium pressure of one atmosphere at 355°, approximately 500° below the decomposition temperature of pure BaO_2. In a few systems a comparatively small rise in the decomposition temperature is indicated. In all instances, however, the rate of oxygen evolution is significantly increased.

A new clock reaction: G. S. FORBES, H. W. ESTILL, and O. J. WALKER. The induction period, t, preceding precipitation of As_2S_3 from H_3AsO_3 or H_3AsO_4 in the presence of $H_2S_2O_3$, is extraordinarily sharp and reproducible. In the case of H_3AsO_3, $1/t = KC\ Na_2S_2O_3$, but is independent of $C\ H_3AsO_3$, and also of C H provided $HC_2H_3O_2$ or very dilute HCl is used. The period increases greatly with C HCl. The rate of precipitation, also highly reproducible, is very great at first, di-

minishes very rapidly, but may not become zero before 3,000 hours at room temperature. With $HC_2H_3O_2$ the initial rate $= k'C$ H, but with moderate values of C HCl this proportion becomes inverse. Many other regularities, likewise affording clues to the reaction mechanism, have been noted.

The volumetric oxidation of sulfide to sulfate: H. H. Willard and W. E. Cake. The alkaline sulfide solution obtained by absorbing H_2S in NaOH is oxidized quantitatively to sulfate if excess of standard hypobromite or hypochlorite is added, and sufficient hydroxide is present. The excess is then determined by adding KI, acidifying, then titrating the iodine with thiosulfate. The method may be applied also to freshly precipitated sulfides, such as ZnS. Since four times as much oxygen is required in this reaction as in the usual iodine titration, the method is especially suitable for small amounts of sulfur.

Making scientists: Recovering the normal curiosity in college students: Edward Ellery. A normal boy and the investigating scientist have this in common—they are both living interrogation points. The investigator minus a "why" is an anomaly, and a boy without it is abnormal, if not defective. If college training knocks the natural "why" out of a boy, a reform can not too soon be instituted. Here is the way Union College is working to effect such a reform. At every opportunity work is required that takes the boy away from his textbook and laboratory manual and into the library for consultation of larger treatises and current periodicals. In the summer months, at the end of the junior year, a few of the best students receive appointments to the research laboratory of the General Electric Company, where they handle a piece of research work under the direct supervision of the leading members of the staff of that organization. In their last year in college, their time in the chemical laboratory is given to a continuation of this research work, or to a new problem. It is only the unconquerably dull boy that fails to react to this effort to awaken his natural "why."

The apparent irreversibility of the calomel electrode: A. W. Laubengayer. When mercury is made anode in a chloride solution a high-resistance, black film forms over the surface of the mercury. This is composed of drops of mercury and particles of mercurous chloride. It is not known why mercurous chloride should be adsorbed so closely and mercurous sulphate not.

The theory of hydrogen overvoltage: D. A. MacInnes and W. R. Hainsworth. Experiments on the effect of pressure on hydrogen overvoltage show that the variation produced is in the direction predicted by the theory advanced by MacInnes and Alden; *i.e.*, the overvoltage increases when the pressure is decreased. On the other hand, computation of the overvoltage from the size of evolved bubbles fails for layer potentials, since the phenomena at metal surfaces get farther and farther away from equilibrium conditions as higher overvoltages are reached. However, the fundamental assumption that overvoltage is an extreme case of concentration polarization, retains its usefulness in explaining the experimental results, at least for the lower potentials.

The hydrogen electrode under high pressures: W. R. Hainsworth. The variation of the E. M. F. of the cell, H_2|HCl (C.1nHCl), HgCl/Hg, with pressure has been measured from one to 400 atmospheres. It was found that thermodynamic calculations involving (1) the deviation of hydrogen from a perfect gas, (2) the partial molal volume of HCl in 0.1 NHCl, (3) the molal volumes of mercury and calomel, and (4) the change of HCl concentration with the compressibility of the solution, served to reproduce the observed potential of the cell within 0.2 mv. throughout the pressure range studied. This leads to the conclusions, (*a*) that the "thermodynamic environment" is not appreciably changed by the molecular hydrogen in solution, or by compression, and (*b*) that the fugacity (or effective pressure) of hydrogen can be calculated up to 400 atmospheres from the equation of state developed by Keyes.

Potassium ammonoaluminate and ammonomanganite: Francis W. Bergstrom. The author has added an ammonoaluminate and an ammonomanganite of potassium to Franklin's list of salts formed by the action of potassium amide, in liquid ammonia solution, on the amides, imides or nitrides of other metals. The aluminate has been prepared by the action of a solution of potassium amide on amalgamated metallic aluminium. Its composition is represented by the formula $Al(NHK)(NH_2)_2$. Potassium ammonomanganite has been obtained in the form of rose colored crystals by the action of an excess of potassium amide on manganese thiocyanate in accordance with the reaction represented by the equation

$$Mn(SCN)_2 + 4KNH_2 = Mn(NHK)_2.2NH_3 + 2KSCN.$$

A quantitative study of adsorption in solution and at interfaces of sugars, dextrin, starch, gum arabic and egg albumen, and the mechanism of their action as emulsifying agents: GEORGE L. CLARK and WM. A. MANN. By the most accurate method known—the use of the stalagmometer for measurement of interfacial tension and the Morgan drop weight apparatus for measurement of surface tension of single liquids—the adsorption of sugar in solution has been determined to be negative, the adsorption increasing in ratio with increase in concentration of sugar, while the adsorption of sugar at the interface is positive and increases in the same ratio as in solution. Dextrin and starch, in very dilute solutions, are negatively adsorbed in solution but, in more concentrated solutions, are positively adsorbed while at the interface they are negatively adsorbed—starch more so than dextrin. Gum arabic behaves, in this respect, in the same manner as starch. A favorable surface tension, seemingly, is not a prerequisite for a good emulsion with any solution studied, although viscosity is an important factor. Better emulsions have been obtained with egg albumen—saturated solutions—than with any other solution under inspection.

The preparation, properties and molecular volume relationships of the ammines and hydrates of cobaltous fluoride, bromide, nitrate, carbonate and citrate: GEORGE L. CLARK and H. K. BUCKNER. The molecular volume compression of the subsidiary valence groups, NH_3 and H_2O, were studied in the same manner as in the previous work on the chloride and sulphate of cobalt (*J. Am. Chem. Soc.*, 42, 2483 (1920)) in light of difference in volumes between anion and cation and possibilities of space cavities. It was confirmed that the larger the difference between anion and cation the greater the possibility of cavities, and the less the compression of NH_3 and H_2O required the more stable the compound and the greater the possibility of holding a maximum number of groups. The various compounds prepared and studied are distinctly new with the exception of cobaltous bromide hexammine and cobaltous nitrate hexammine, the following being representative: cobaltous fluoride hexammine, cobaltous nitrate di-hydrate, ammines of cobaltous nitrate indicating more than six subsidiary valence groups and ammines of cobaltous carbonate and citrate.

Emulsification with soaps of linoleic and ricinoleic acids: GEORGE L. CLARK and H. K. BUCKNER. This work has involved the quantitative study by means of surface energy measurements for solutions and at the interface between aqueous solution and a pure oil by the drop weight method of the following points: the solubility in water of the free acids from the log. concentration-surface tension curve; the adsorption at the surface and the volume occupied by each molecule in the surface; the surface tensions of various concentrations of the soaps in solution, the effect upon the interfacial tension between water and pure toluene, the effect of the hydrolysis of the soap and the prevention of hydrolysis by the addition of various concentrations of NaOH to a given concentration of the soap; a test of the antagonistic effect of sodium and calcium soaps by testing the effect upon the interfacial tension between water and toluene containing a small amount of the free acid of adding various salts of sodium and calcium, resulting in the fact that the sodium salt promotes emulsions of oil in water and calcium salts promote emulsions of water in oil; and finally a thorough comparison of all the data so obtained with previous work on soaps of palmitic, stearic and oleic acids. All results of this purely quantitative study are necessarily numerical and can not be included in a short abstract.

Notes on the preparation of pure platinum: EDWARD WICHERS. The paper briefly states the method used in preparing platinum sponge free from other platinum metals and base metals, and describes in more detail the work that has thus far been done on the conversion of this sponge to compact metal with minimum contamination. E.M.F. tests show the resulting platinum to be of higher purity than the best previously obtainable, *i.e.*, the thermoelement wire of Heraeus, and show the difference in purity to be a matter of calcium content. Results of experiments with magnesia refractories are also given. There is a brief outline of further work to be done on this subject.

Modified method for the determination of iron and vanadium after reduction by hydrogen sulphide: G. E. F. LUNDELL and H. B. KNOWLES. Published methods for the determination of iron and vanadium after reduction by hydrogen sulphide ordinarily yield high values. A modified method which is sufficiently accurate for most purposes is presented, and a procedure for accurate analysis is outlined.

The free energy of dilution of hydrobromic acid; the activities of its ions in very dilute and con-

centrated solutions: Miller Spencer and Albert G. Loomis.

The ultra-violet arc spectrum of yttrium: L. F. Yntema and B. S. Hopkins. The ultra-violet arc spectrum of Y was measured, using the yttrium oxide prepared by one of us for the determination of the atomic weight value accepted by the International Committee. The spectrograph used is an autocollimating quartz prism machine manufactured by Adam Hilger, of London. A current of 4 amperes at an E.M.F. of 220 volts was passed between vertical copper electrodes, the lower of which held the Y_2O_3 in its crater. Several prominent lines, attributed to Y in the literature, were absent, and several new lines were measured. The results given are the mean of five determinations.

On the viscosity of gelatin sols: Robert Herman Bogue. Experiments were carried out upon gelatin sols to accurately determine the relation between viscosity and concentration. The data have been applied to Hatschek's formula for the viscosity of emulsoids and the value A^1/A, representing the volume occupied per unit weight of dispersed phase, was shown not to be constant with varying concentration, but to rise to a maximum and thereafter regularly decline. A tentative explanation is presented based upon the effect which increasing concentrations of dispersed phase will have upon the surface tension of the dispersion medium. An empirical expression defining the departure of the values obtained under varying conditions for Hatschek's constant is given.

The structure of molecules of water: Irving Langmuir. Dennison has recently shown by X-ray crystal analysis that ice consists of molecules of the formula H_4O_2. In view of our knowledge of the structure of atoms it is not possible to account for the existence of this molecule on the basis of quadrivalent oxygen atoms. If pairs of electrons (duplets) constitute the valence bond, there can be no such bond between the two oxygen atoms. A structure for this molecule is therefore proposed in which the four hydrogen nuclei bind the two oxygen atoms. The duplet held by each hydrogen nucleus has one of its electrons in each of the oxygen octets, instead of the more usual arrangement in which both electrons of a duplet form part of the same octet.

The purification of helium by means of charcoal: L. Finkelstein.

The importance of diffusion in organic electrochemistry: Robert E. Wilson and Merrill A. Youtz. The authors, in searching for definite evidence of depolarization in the electrolytic halogenation of organic compounds, found that either slow reaction rate or slow diffusion, or both, prevented any marked depolarization. Experiments on the oxidation of $FeCl_2$ in HCl gave surprisingly accurate information as to the rate of diffusion under a variety of conditions, and showed that without stirring there is a film of stationary liquid about 0.5 mm. thick through which diffusion must take place. This emphasizes the great importance of violent stirring and of the use of rapidly diffusing inorganic carriers to extend the sphere of the organic reaction from a surface to a volume.

Observations on the drying and swelling of gelatine gels: S. E. Sheppard and F. A. Elliott. Attention is drawn to the importance of capillarity in the first phase of drying of jellies. It is shown that this, in conjunction with factors depending upon the shape of the jelly, causes the formation of an exo-skeleton tending to conserve or increase the original external surface extension. It is chiefly due to this, rather than to any internal supermolecular structure, that dried jellies on reswelling in water tend to return to their original concentration.

Note on the influence of silver salts in catalyzing the decomposition of ammonium persulphate solutions: S. E. Sheppard and A. Ballard. The influence of silver salts in facilitating the decomposition of ammonium persulphate in solution, first observed by H. Marshall and J. Inglis, has been confirmed, and quantitative data on the rate of change in relation to the silver content obtained.

Further developments of the hydrogen electrode: Felix A. Elliott. Two new forms of hydrogen electrode were described representing probably the limits of simplicity and ruggedness without reducing accuracy and rapidity of operation. Especial attention has been given in designing this new apparatus to reduce the internal resistance to the lowest possible value so that a less sensitive and hence cheaper, simpler and portable electrical measuring instrument might be used. Such an instrument was described, working on the potentiometer principle and employing a pivot type movement. Examples of results obtained with the two types of apparatus indicate that potentials are reproducible to about 0.1 mv.

Note on silver soap gels: G. Stafford Whitby. It has been observed that the silver salts of the fatty acids are capable of giving reversible gels in a variety of organic liquids—particularly in the

homologs of benzene and in halogenated derivatives of benzene and its homologs. The silver salts form gels at a lower point in the series of saturated fatty acids than do the alkali-metal salts; gels being obtained with silver caproate. A number of regularities were discernible. The silver salts of the higher members of the saturated fatty acid series show a greater solvation capacity than those of the lower ones. None of the saturated fatty acid silver salts gave a gel in benzene; but silver oleate did. Speaking generally, in the case of solvents of the same general chemical character, the higher the boiling point of the solvent, the greater appeared to be the solvation capacity of a given salt, and the smaller the extent to which the gel from a given salt suffered syneresis.

Catalytic effect in the reaction between ketones and halogens in aqueous solutions: F. O. RICE. The velocity constant of the reaction between acetone and bromine is independent of the bromine concentration and Lapworth (*J. C. S. Trans.*, 1904, p. 30) explained this by saying that the acetone slowly enolized and the addition of bromine and splitting off of hydrobromic acid were practically instantaneous. This is probably incorrect since higher ketones have the same velocity constant as acetone, and an explanation based on the radiation theory was offered. The reaction is accelerated by neutral salts contrary to Lapworth's statement.

The transference numbers of sulfuric acid by the concentration cell method: A. L. FERGUSON and W. G. FRANCE. A cell combination was used which permitted the measurement of all the required potentials from one set-up. The value obtained for the transference number for the anion in concentrations between $M/10$ and $M/100$ at 25° C. was $.1868 \pm .0007$. The method was shown to be highly reliable. In all of the calculations it was assumed that sulfuric acid dissociates into two hydrogen and one sulfate ion. This assumption was substantiated by the results obtained. A formula for boundary potential was developed in which boundary potential may be obtained from potential measurements alone.

The influence of gelatin on the transference numbers of sulfuric acid: ALFRED L. FERGUSON and W. G. FRANCE. The transference numbers were determined by the concentration cell method. Solutions of sulfuric acid containing from 0.5 per cent. to 20 per cent. gelatin were used. The transference numbers of the anion increased from .187 for pure acid to .685 for acid containing 20 per cent. gelatin. In the 20 per cent. gelatin solution the boundary potential of both concentration cells became zero. The decrease in conductivity was approximately proportional to the gelatin added. The results are probably best explained on the assumption that there is a chemical action between the gelatin and sulfuric acid in which a single compound is formed. In this compound the hydrogen of the acid loses its identity and when the compound dissociates there is formed a complex gelatin hydrogen positive ion and a negative sulfate ion.

The entropy of monatomic gases: GILBERT N. LEWIS.

The electrometric titration of uranium with potassium dichromate and potassium permanganate: D. T. EWING and E. F. ELDRIDGE.

The heat of coagulation of ferric oxide hydrosol by electrolytes: FREDERICK L. BROWN and J. H. MATHEWS.

Some quantitative experiments on coagulation of colloids: RAY V. MURPHY and J. H. MATHEWS. The lowest concentration (limiting concentration) of electrolytes necessary to coagulate hydrous ferric oxide sol has been studied as a function of the purity of the sol (ratio of gram-equivalents of Fe to gram-equivalents of Cl) and of the concentration of Fe_2O_3. Chloride, chromate and ferricyanide ions were used in the form of the potassium salts. The conclusions drawn are: (1) The limiting concentration decreases with increasing purity in the case of all three ions, the mechanism of the process being evidently similar for the three ions; (2) The limiting concentration decreases markedly with decreasing concentration of the sol in the case of all three ions, but the relation indicated by Burton and Bishop, *Jour. Phys. Chem.*, 24, 701 (1920), for mastic, As_2S_3 and Cu sols, holds for Fe_2O_3 hydrosol only in the case of the trivalent ion.

The alkalinity of Searles Lake brine: ROGER C. WELLS. The title may mean either the titration alkalinity or the hydrogen ion concentrations. The latter may be considered as determined by certain proportions of the four buffer substances Na_2CO_3, $NaHCO_3$, $Na_2B_4O_7$, and $Na_2B_2O_4$. The writer has found for the brine $P_H = 9.48$. By determining the P_H values of artificial brines containing each pair of buffers separately it is possible to draw curves from which by interpolation the proper proportions of the buffers to yield $P_H = 9.48$ may be read. This method serves as a check of the analyti-

cal determinations and yields a logical conventional form for expressing the whole analysis of the brine.

The vapor density of technical phosgene: A. F. O. Germann and Vernon Jersey. A 75 gm. sample of technical phosgene was distilled from a large cylinder of the liquefied gas, obtained from the Chemical Warfare Service through Dr. Goss. Pure phosgene has a vapor tension at 0° C. of about 552 mm.; the sample taken showed a vapor tension in excess of one atmosphere at — 80° C., that is, in a bath of solid carbon dioxide and acetone. The sample was subjected to fractional distillation in a vacuum until the vapor tension at 0° C. was approximately correct. Following this, three fractional distillations alternated with three determinations of the vapor density of the gas, until five groups of three determinations each had been obtained for the vapor density, and the nearly pure gas had been fractionally distilled 15 times.

Average of	1st	group	of	densities	.....	4.4708
"	" 2d	"	"	"	.....	4.5060
"	" 3d	"	"	"	.....	4.5216
"	" 4th	"	"	"	.....	4.5244
"	" 5th	"	"	"	.....	4.5263

The values given are in grams per liter at standard conditions, uncorrected for the compressibility of the gas and for the contraction of the globes when evacuated. Technical phosgene is very impure. The principal impurities are very volatile and of relatively low molecular weight, probably carbon dioxide and hydrogen chloride resulting from hydrolysis. Repeated fractional distillation yields a product whose density tends toward a maximum value, probably the value for pure phosgene.

The cryoscopy of boron trifluoride solutions: V. Systems with methyl ether and with methyl chloride: A. F. O. Germann and Marion Cleaveland. Gasselin prepared the compound $BF_3.(CH_3)_2O$ by mixing the gases; he obtained a liquid boiling at 126° C. This compound has been prepared from liquid boron trifluoride and liquid methyl ether in the course of the determination of the melting point curve of solutions of the two substances. The curve shows a eutectic at 3 per cent. BF_3 (molecular percentages) and a maximum at 50 per cent. The vapor tensions of solutions containing from 60 per cent. to 90 per cent. BF_3 were so high, that the form of apparatus used was inadequate. The form of the curve so far as determined seems to indicate the existence of a second compound in this interval. Methyl chloride was prepared from salt, sulfuric acid and wood alcohol; was purified by repeated fractional distillations; and gave the usual indications of a pure substance, such as constant freezing point for the first and last fractions of the liquid. The melting point curve with BF_3 shows two maxima, at 15 per cent. BF_3, and at 33 per cent. BF_3, and an angular point in the curve at 50 per cent. The form of the maxima at 15 per cent. is identical with that at 50 per cent. for methyl ether; the mixture yields about 15 per cent. of the total volume of a liquid, whose freezing and boiling points are identical with those of $BF_3.(CH_3)_2O$. The logical inference is that methyl chloride as prepared contains methyl ether as an impurity, and that this impurity yields a constant boiling mixture. It would seem that boron trifluoride might be used as a test for the presence of methyl ether in methyl chloride; the same test might be extended to the homologues. The interpretation of the other maxima mentioned must await the completion of further work on the purity of methyl chloride.

The cryoscopy of phosgene solutions: I. System with chlorine: A. F. O. Germann and V. Jersey. The melting point curve of solutions of phosgene and chlorine was determined. The curve is very complex. There is a eutectic at 25 per cent. (molecular percentages) chlorine; and angular points in the curve at 6 per cent., 11 per cent., 50 per cent., 63 per cent., 75 per cent. and 91 per cent. chlorine. The following compounds, which dissociate at the melting point, are indicated: $16COCl_2.Cl_2$; $8COCl_2.Cl_2$; $COCl_2.Cl_2$; $3COCl_2.5Cl_2$; $COCl_2.3Cl_2$; and $COCl_2.10Cl_2$. The second of these, chlorine octaphosgenate, is particularly interesting, as corresponding with the octahydrate of chlorine. The affinity of chlorine for phosgene, and the instability of the compounds would seem to offer an explanation of the mechanism of certain phases of the catalysis of carbon monoxide and chlorine by means of charcoal saturated with chlorine. If we assume a layer of chlorine molecules on the surface of the charcoal, the high concentration of chlorine thus obtained might be supposed in the presence of carbon monoxide to shift the equilibrium in the direction of one of the chlorine-phosgene complexes, which promptly decomposes because of its instability, leaving the surface film of chlorine for further action. It would be desirable to determine the melting point curve of carbon monoxide and chlorine solutions, to clear up some of the points involved in this reaction.

Charles L. Parsons,
Secretary

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